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ABSTRACT

A study investigated children's and adults' abilities to derive inferences requiring the integration of two episodic premises (episodic inferences) and inferences requiring the integration of one episodic premise with extra-stimulus, semantic knowledge. Subjects, 95 kindergarten, third grade, seventh grade, and college students, watched either an integrated version or a separated version of an animated audiovisual program, and then answered episodic inference, semantic inference, and verbatim memory questions regarding the program. Results indicated that (1) all subjects could draw inferences using episodic or semantic information; (2) subjects could integrate episodic information across separately-presented episodes to derive inferences; (3) college students were better than kindergartners at integrating episodic information viewed in the separated version; and (4) college students, seventh graders, and third graders were better than kindergartners at using semantic information to derive inferences. Findings support the unitary view of long-term memory. (Two figures of data are included, and 43 references are attached.) (RS)

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Children's and Adults' Abilities to Use Episodic and Semantic Information to Derive Inferences

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Abstract

Children's and adults' abilities to derive inferences requiring the integration of two episodic premises (episodic inferences) and inferences requiring the integration of one episodic premise with extra-stimulus, semantic knowledge (semantic inferences) were investigated. Kindergarteners, 3rd graders, 7th graders, and college students watched either an integrated version or a separated version of an animated audiovisual program, and then answered episodic inference, semantic inference, and verbatim memory questions regarding the program. Results indicate that when they remember the requisite premises, individuals at each grade level can draw inferences using primarily episodic as well as primarily semantic information. They can also integrate episodic information across separately presented episodes to derive inferences when they remember the requisite premises. However, when subjects view the separated version of the program, college students are better than kindergarteners at integrating episodic information to derive inferences, and college students, 7th graders, and 3rd graders are better than kindergarteners at using semantic information to derive inferences. The results provide support for the unitary view of long-term memory (e.g., Anderson, 1983; Naus & Halasz, 1979; McKoon, Ratcliff, & Dell, 1986) and for Tulving's (1984b, 1986) embeddedness view of episodic and semantic memory. Possible explanations for the obtained developmental differences are proposed.

Children's and Adults' Abilities to Use Episodic and Semantic Information to Derive Inferences

The distinction between episodic and semantic memory has been a source of debate for many years. Although it was presented initially as a heuristic device (Tulving, 1972), several cognitive and developmental psychologists (Atkinson, Hermann, & Wescourt, 1974; Brown, 1975; Hermann & Harwood, 1980; Lockhart, Craik, & Jacoby, 1976; Moeser, 1976, 1977; Tulving, 1976, 1983, 1984a; Watkins & Tulving, 1975) have regarded the distinction as a functional one with episodic and semantic memory representing separate long-term memory systems differing both in content and memorial processes (see Tulving, 1983, 1984a). Regarding the content differences, Tulving (1972, 1983, 1984a, 1984b, 1985, 1986) proposed that the episodic system stores and processes temporally dated autobiographical information, personal experiences, and particular events or episodes. The semantic system was proposed to store and process meaningfully organized, general knowledge of the world, independent of autobiographical instances. While generally accepting the content differences, unitary long-term memory theorists have argued that episodic and semantic information are stored in a single long-term memory system with the same proceses operating upon both types of information (Anderson, 1976, 1983; Anderson & Ross, 1980; Lachman & Naus, 1984; McKoon, Ratcliff, & Dell, 1986; Naus & Halasz, 1979). Empirical demonstrations of processing similarities and/or

differences associated with episodic and semantic information are needed to determine if the two differ in both content and cognitive function, or in content only.

An important process initially thought to operate differently in the two proposed systems is inferential reasoning. Inferential reasoning was originally thought to operate within the proposed semantic system, but not within the proposed episodic system (Tulving, 1972). It was later hypothesized that the semantic system had rich, whereas the episodic system had limited, inferential capability. That is, the meaningful, interconnected organization of semantic memory purportedly allowed for the integration and recombination of semantic information, which, in turn, permitted the generation of inferences. The proposed temporal, non-meaningful organization of episodic memory purportedly limited its inferential capability such that inferences could not be made on the basis of episodic information, but could be made only on the basis of semantic information which may be contained within an episodic event. Furthermore, it was hypothesized that knowledge about the contents of an event could be derived only from the stored representation of that particular event, and not from other events, or episodes (Tulving, 1983).

Arguing against the notion of limited episodic inferential capability, McCauley (1984) proposed that individuals sometimes make inferences based solely upon episodic information. He argued that at

the time of encoding, we frequently do not realize and thus do not encode the relationship between a newly experienced event and an event already stored in memory. He further argued that such relationships often become evident only after a future third event occurs. For such relationships to become evident, individuals would have to be capable of integrating episodic information. They would also have to be able to integrate episodic information presented in separate events. Hence, McCauley (1984) concluded that the processing of episodic information is sometimes necessarily inferential.

Tulving (1984b) modified his positions on the episodic-semantic distinction and inferential reasoning as a result of McCauley's (1984) assertion and critiques by others (e.g., Kihlstrom, 1984; Lachman & Naus, 1984; Seamon, 1984; Tiberghien, 1984; Wolters, 1984). According to Tulving's (1984b, 1986) recent view, the episodic system is a sub-system of the semantic system and has "... at its disposal all the resources of the semantic system ..." (Tulving, 1984b, p.259). Functionally, Tulving's recent view appears equivalent to the unitary view of long-term memory (McKoon, Ratcliff, & Dell, 1986). Regarding the inferencing process per se, proponents of the unitary view and of Tulving's recent view would predict that individuals can make inferences on the basis of episodic, as well as on the basis of semantic, information.

Although hypotheses regarding the inferential processing of episodic and semantic information have been proposed and subsequently modified (McCauley, 1984; Tulving, 1972, 1983, 1984b), relatively little research designed to directly test those hypotheses have been conducted. To empirically determine whether inferences can be made on the basis of semantic information only (Tulving, 1972, 1983), or whether they can also be made on the basis of episodic information (McCauley, 1984; Tulving, 1984b), studies should be designed to include two types of inferencing tasks, an episodic inference task and a semantic inference task. Based upon Tulving's definitions of episodic and semantic memory (Tulving, 1972, 1983, 1984b, 1986), the episodic inference task should require the integration of at least two pieces of newly presented, stimulus (i.e., episodic) information and the semantic inference task should require the integration of a stimulus premise with extra-stimulus, general world knowledge (i.e., semantic information). In addition, studies assessing individuals' relative abilities to integrate episodic information presented in temporally separated events versus episodic information presented in a single event would help to determine if information regarding a particular event can be derived from that event only (Tulving, 1983) or if such information can be deduced from other episodic events as well (McCauley, 1984; Tulving, 1984b).

Bourg, Naus, and Siegel (1986) compared adults' abilities to derive episodic and semantic inferences from an audiovisual program

presented either as a single, integrated event or as five temporally separated events. The episodic inferences required the integration of two pieces of actual event, or stimulus, information. The two premises were positioned within the audiovisual program such that subjects who viewed the program as five separated events had to integrate the information across the discrete events to derive the inferences. The semantic inferences required the integration of a piece of stimulus information with extra-stimulus, general knowledge. Results indicated that when adults remember the necessary premises, they are equally proficient at deriving both types of inferences, and they are also able to integrate episodic information from temporally separated audiovisual events to derive inferences. Hence, it appears that the inferential processing of adults operates similarly with episodic and semantic information, and that at least when asked to do so, adults can deduce information regarding a particular event by integrating information presented in that event with information presented in an event encoded at a different time.

Few, if any, studies designed specifically to assess developmental differences in the relative ability to inferentially process episodic and semantic information have been conducted. Developmental tests of the different hypotheses regarding the ability to make inferences on the basis of episodic information presented in events encoded at different times (i.e., McCauley, 1984; Tulving, 1983, 1984b) are also rare. However, age-related improvements in the

ability to integrate stimulus information with extra-stimulus semantic knowledge have been found (e.g., Paris, 1975; Paris & Lindauer, 1977; Paris, Lindauer, & Cox, 1977; Paris & Upton, 1976). Developmental differences in the ability to integrate stimulus, or episodic, premises to derive inferences have also been found (e.g., Collins, 1973; Collins, Wellman, Keniston, & Westby, 1978; Johnson & Smith, 1981). In a study investigating episodic-like and semantic-like inferences, Thompson and Meyers (1985) did find that 7-year-olds were better than 4-year-olds at deriving inferences involving causal connections between story events (episodic) and at deriving inferences requiring general world knowledge about story events and objects (semantic). Contrary to any of the aforementioned episodic-semantic inferential reasoning hypotheses (McCauley, 1984; Tulving, 1972, 1983, 1984b), Thompson and Meyers also found that both 4- and 7-year-olds performed better on the episodic-like than on the semantic-like inferences.

Findings of developmental differences in the ability to integrate episodic premises from separate stimulus events versus the ability to integrate episodic premises located within a single stimulus event are mixed. For example, Moeser (1976) found that kindergarteners, second, sixth, and ninth graders were better able to derive inferences when premises were presented in single, holistic sentences, rather than in separate sentences. However, using audiovisual stimuli, which possess richer supportive contexts than

sentences, Collins (1973) found that third graders apparently had difficulty integrating information in temporally separated scenes, but sixth and tenth graders were apparently able to integrate information across temporally separated scenes. Because Collins (1973) was interested in the effects of temporal separation between audiovisual scenes on responses to a self-aggression-potential measure, his results are limited for drawing conclusions regarding the various episodic inferential reasoning hypotheses (i.e., McCauley, 1984; Tulving, 1972, 1983, 1984b). Using an inferential reasoning reading task, Johnson and Smith (1981) obtained similar results in that third graders were better able to derive inferences when premises were presented within as opposed to between paragraphs. Sixth graders, however, were equally capable of integrating premise information between and within paragraphs to derive inferences.

In the present study, developmental differences in the relative ability to derive inferences on the basis of semantic information and on the basis of episodic information were investigated. Kindergarteners, third graders, seventh graders, and college students viewed an animated audiovisual program that was presented either as five temporally separated episodes or as one integrated episode. After viewing the program, the subjects answered episodic inference, semantic inference, and verbatim memory questions about the program. The episodic inference questions required the integration of two program premises. The premises were positioned such that subjects

who viewed the program as separate episodes had to integrate the premises across the episodes to derive the inferences. The semantic inference questions required the integration of one program premise with extra-stimulus knowledge. The episodic and semantic inference questions were included to determine if there are developmental differences in the relative ability to derive inferences on the basis of episodic and on the basis of semantic information. The verbatim memory questions were included to assess subjects' memory for requisite premises and to provide a premise memory correction factor onto the inferential reasoning performance. The correction factor was important for concluding that results were due to something inherent in the inferencing process per se and not to differences in memory for premises.

The separated or integrated presentation manipulation was included to directly test in a developmental fashion McCauley's (1984) and Tulving's (1983, 1984b) hypotheses on episodic and semantic memory and inferential reasoning. Although, neither McCauley nor Tulving considered a developing memory system in these particular arguments. The comparison of subjects' episodic inferential performance in the separated versus integrated presentation conditions was important for determining whether children as well as adults can integrate episodic information and infer relationships from separate events (McCauely, 1984; Tulving, 1984b) as well as from one particular event (Tulving, 1983).

Findings that children, as well as adults, are capable of deriving such inferences under both separated and integrated presentation conditions would provide suppport for McCauley's (1984) episodic inference hypothesis, and would provide partial suppport for the unitary long-term memory position that the same cognitive processes operate upon episodic and semantic information (e.g., Anderson, 1976, 1983; Anderson & Ross, 1980; McKoon, Ratcliff, & Dell, 1986; Naus & Halasz) and for Tulving's (1984b) recent view of episodic and semantic memory. Although prior research indicates that adults can infer relationships regarding a particular event by integrating episodic information from discrete events (Bourg, Naus, & Siegel, 1986), children at different points of development may have difficulty integrating premises from separate events (e.g., Collins, 1973; Johnson & Smilth, 1983). Developmental differences in the ability to integrate episodic information across discrete events and/or developmental differences in the ability to use episodic versus semantic information to derive inferences would warrant further explication of the relationship between episodic and semantic memory and inferential reasoning, and would necessitate a developmental view of that relationship.

Method

Subjects

Ninety-five students participated in the study. Twenty-three kindergarteners (mean age = 5.9 years) and twenty-four third graders

(mean age = 8.8 years), seventh graders (mean age = 12.6), and college students (mean age = 23.9 years) served as subjects. The kindergarteners, third, and seventh graders were recruited from two elementary schools, one located in a small southern city and the other located in a small western city. The compositions of the two schools were similar. The southern school consisted of grades K - 7 and the western school consisted of grades K - 8. Both schools had only one class at each of the grade levels used in the present study. Each class consisted of approximately 25 - 30 children who came from predominantly middle class homes. The adult subjects were enrolled in lower division undergraduate psychology courses at California State University, Sacramento. Their participation enabled them to partially fulfill course requirements. Approximately half of the subjects at each grade level were female and approximately half were male.

Materials

Stimuli. An edited version of an animated children's television program was used. The program was edited to include only plot-essential scenes as identified by adult judges. The program was approximately 13 minutes in length, and was divided into five scenes, or episodes (i.e., a beginning, three middle, and a concluding episode). Each episode was approximately two and one-half minutes long.

The program was about the adventures of a little girl named Alyson, her cat, and a friendly alien named Twyler. The main plot involved their efforts to regain control of an important object called an orb, which had been stolen from Twyler's planet by evil aliens. Regaining control of the orb would have important consequences for both Earth and Twyler's planet, Wobbly.

Test Questionnaire. After viewing the stimulus program, subjects were asked to answer questions about its contents. The questions were read to subjects and they responded orally. Subjects' responses were recorded in written format by the experimenter. The questionnaire consisted of three types of recall questions: 1) episodic inference, 2) semantic inference, and 3) verbatim memory questions. There were 11 episodic inference, 11 semantic inference, and 13 verbatim memory questions.

Answers to the episodic inference and to the semantic inference questions were not explicitly stated in the program. Episodic inference questions required subjects to integrate stimulus information from separate episodes to infer the answers. Semantic inference questions required the integration of stimulus information presented in a single episode with existing general world knowledge to derive the answers. Verbatim memory questions assessed memory for information explicitly stated in the program. Some verbatim memory questions assessed memory for the stimulus premises from which the inferences were derived. Below are examples of the three question

types:

Episodic Inference Question: What did Alyson see the first time she and Winston went to the treehouse? (requires the integration of information from episodes 1 and 2)

Answer: the orb

Semantic Inference Question: How did Alyson and Winston feel when Twyler left? (requires information from episode 4 and prior knowledge of how people feel when they behave in certain ways)

Answer: sad

Verbatim Memory Question: Where is Twyler from? (explicitly stated in episode 2)

Answer: Wobbly

So that responses to the verbatim memory questions would not influence responses to the inference questions, the episodic and semantic inference questions were presented first, in a counterbalanced order. The same order was used for each subject.

Design and Procedure

The study was a 2 (Presentation: Integrated, Separated) X 4 (Grade: K, 3, 7, College) X 3 (Question Type: Episodic Inference, Semantic Inference, Verbatim Memory) mixed-model design. The Question Type factor was a within subjects variable.

Each subject viewed the stimulus program on a 13-inch color television monitor, and was tested individually. Subjects were instructed to pay close attention to the program because they would be asked questions about it later. Within each grade level, subjects were randomly assigned to either the integrated or separated presentation condition.

The 48 subjects in the integrated presentation condition viewed the program as a single event with no temporal separations between the episodes. After viewing the program, they responded to the test questionnaire.

The 47 subjects in the separated presentation condition viewed the program with two and one-half minute intervals between the five episodes. During the separation periods, subjects worked on a pencil-and-paper task completely unrelated to the stimulus program. The intervening task was thought to break the narrative flow of the program and to encourage independent storage of the separate episodes. The third graders, seventh graders, and college students completed items from a Mental Rotations Test during the separation periods. The kindergarteners worked on an alphabet and number tracing task, a more comprehensible task for that grade level. After viewing the entire program, subjects completed the test questionnaire phase of the study.

Scoring and Interrater Reliability

The dependent measures were the proportion of correct episodic

inference, semantic inference, and verbatim memory questions. Each answer was scored on a 0 - 3 point scale. A score of 3 was given for each completely correct answer. A score of 2 was given for each answer that contained some information regarding the crucial component of the correct answer, but had some missing details. An answer received a score of 1 if it contained information remotely related to the correct answer, but excluded the crucial component and adequate details. A score of 0 was given for each completely incorrect answer. To assess interrater reliability, answers to the episodic inference questions and to the semantic inference questions for each subject were independently scored by two raters. Because the correct answers to the verbatim memory questions were straightforward and based upon explicitly stated stimulus information, an assessment of interrater reliability for those questions was not conducted. Interrater reliability for the episodic inference scores was determined by calculating the correlation between the values calculated for each rater on the episodic inference questions. The same procedure was carried out on the semantic inference scores. The Pearson *rs* were .99 for the episodic inference scores and .99 for the semantic inference scores, indicating very high interrater reliability.

Results

Episodic and Semantic Inferencing Performance

The mean proportion correct episodic and semantic inference

questions were entered into a 2 X 4 X 2 (Presentation X Grade X Question Type) mixed model ANOVA, with the Question Type factor as a within subjects variable. The analysis revealed significant main effects of Grade, F (3, 87) = 64.82, $p < .001$, $\eta^2 = .67$ and Presentation, F (1, 87) = 4.52, $p < .04$, $\eta^2 = .015$, and a significant Presentation X Question Type interaction effect, F (1,87) = 6.05, $p < .02$, $\eta^2 = .008$.

Post hoc analyses of the Grade main effect indicated that college students (M = .80) performed better than third graders (M = .67) and kindergarteners (M = .36) on the episodic and semantic inference questions. Seventh graders (M = .78) performed better than third graders, and third graders performed better than kindergarteners on the episodic and semantic inference questions (Spjotvoll-Stoline, $ps < .05$).

As suggested by Keppel (1982), Type I errors were controlled at the level of simple main effect and simple interaction effect analyses as well as at the level of simple pairwise comparisons. To determine the source of the Presentation X Question Type interaction, tests of its simple main effects were conducted. The critical p value controlling for Type I errors in the simple main effects analyses was calculated by multiplying .05 by the degrees of freedom associated with the Presentation X Question Type interaction and dividing that product by the number of possible simple main effects. Thus, critical p = (.05 X 3)/4 = .0125. As illustrated in Figure 1,

tests of the simple main effects of the Presentation X Question Type interaction indicated that for all four grade levels, subjects in the integrated presentation condition (M = .69) performed better than subjects in the separated presentation condition (M = .61) on the episodic inference questions, F (1, 92) = 6.74, p < .0125.

Insert Figure 1 about here

Memory for Explicit Program Information

The mean proportion correct verbatim memory questions were subjected to a 2 X 4 (Presentation X Grade) ANOVA which yielded a significant main effect of Grade, F (3,87) = 38.70, p < .001, η^2 = .57. Spjotvoll-Stoline tests (ps < .05) indicated that third graders (M = .73), seventh graders (M = .83), and college students (M = .82) remembered more explicitly presented information than kindergarteners (M = .49). Seventh graders (M = .83) remembered more explicit information than third graders, and the difference between college students' and third graders' verbatim memory performance approached significance.

Relation of Episodic and Semantic Inferences to Memory for Premises

Certain verbatim memory questions assessed memory of the stimulus premises necessary for answering the episodic and semantic inference questions. To eliminate any influence of differences in

memory for stimulus premises on inferential reasoning performance, the proportion of correct episodic and semantic inference questions for which memory of stimulus premise information had been demonstrated was calculated for each subject. These conditional scores were entered into a 2 X 4 X 2 (Presentation X Grade X Question Type) mixed-model ANOVA. The ANOVA revealed a significant Grade main effect, F (3, 86) = 35.56, $p < .001$, $\eta^2 = .52$, and a significant Grade X Presentation X Question Type interaction effect, F (3, 86) = 4.75, $p < .01$, $\eta^2 = .07$.

Tests of the simple interaction effects were conducted to determine the source of the triple interaction (critical p = [.05 X 3 df]/3 possible simple interaction effects = .05). The simple Presentation X Question Type interaction effect was significant at the third grade level only, F (1, 22) = 7.31, $p < .05$. The simple Presentation X Question Type interaction effect was due to the relatively greater semantic inferencing performance of third graders in the separated (M = .81) rather than in the integrated (M = .65) presentation condition, F (1, 22) = 6.94, p = .01 (critical p = [.05 X 1 df for simple Presentation X Question Type interaction]/4 possible simple main effects = .01).

For ease of interpretation, Figure 2 shows the three-way interaction as resulting from a significant simple Grade X Question Type interaction effect for the separated presentation condition, F (3, 42) = 4.57, $p < .01$, but not for the integrated presentation

condition. Further analyses indicated that the simple main effect of Grade was significant for episodic, F (3, 42) = 4.09, $p < .02$, and for semantic, F (3, 42) = 18.49, $p < .001$, inference questions in the separated presentation condition (critical p = [.05 X 3]/6 = .025). As shown in Figure 2, college students (M = .84) correctly derived more episodic inferences than kindergarteners (M = .60) in the separated presentation condition. Third graders (M = .81), seventh graders (M = .81), and college students (M = .86) derived more correct semantic inferences than kindergarteners (M = .40) in the separated presentation condition (Spjotvoll-Stoline, $ps < .05$).

Although the simple Grade X Question Type interaction was not significant for the integrated presentation condition, the Grade main effect was, F (3, 43) = 20.14, $p < .001$. As illustrated in Figure 2, seventh graders (M = .84) and college students (M = .89) in the integrated presentation condition were better able to derive episodic and semantic inferences than kindergarteners (M = .49) in the integrated presentation condition. The difference between kindergarteners' and third graders' (M = .69) and between third graders' and college students' episodic and semantic inference performance in the integrated condition approached significance.

Insert Figure 2 about here

Discussion

The results of the present study indicate that when kindergarteners, third graders, seventh graders, and college students remember the requisite premises, they can draw inferences using episodic as well as semantic information. Furthermore, they are able to derive inferences by integrating episodic information across discrete audiovisual events as well as from within a single audiovisual event when they remember the necessary premises.

Recall that before memory for premises is taken into consideration, individuals who view an audiovisual program as one integrated episode derive more episodic inferences than those who view the program as five separate episodes. However, when memory for premises is controlled by analyzing only answers to inference questions for which memory of stimulus premises is demonstrated, the difference between the episodic inference performance of individuals in integrated and separated presentation conditions disappears. The initial difference is due, then, to differences in memory for premises and not to differences in the ability to inferentially process episodic information across discrete episodes versus the ability to inferentially process episodic information within a single episode. These findings support McCauley's (1984b) assertion that the processing of episodic information can be inferential in nature and that information can be deduced from separate episodic events.

The demonstration that the processes of information integration

and inferential reasoning operate upon both episodic and semantic information provides support for the unitary view of long-term memory, which posits that episodic information, semantic information, and combinations of episodic and semantic information are stored in a single long-term memory system with the same processes operating upon that information (e.g., Anderson, 1976, 1983; Anderson & Ross, 1980; McKoon, Ratcliff, & Dell, 1986; Naus & Halasz, 1979). Future studies should determine the extent to which processes other than information integration and inferential reasoning can operate upon both episodic and semantic information.

The present findings can also be interpreted to support Tulving's (1984b, 1985, 1986) recent view of the episodic system as a sub-system embedded within the semantic system. The embeddedness view dictates that all processes that operate upon semantic information can operate upon episodic information, but that not all processes that operate upon episodic information can operate upon semantic information. The embeddedness view addresses McCauley's (1984) logical argument regarding the inferential processing of episodic information by affording the episodic system with the semantic memory process of inferential reasoning (Tulving, 1984b). The present study provides empirical support for McCauley's logical assertion and for Tulving's (1984b) proposal that the episodic system has access to the processing resources of the semantic system. Unless further research demonstrates that there are processes that

can operate upon episodic information but not upon semantic information, Tulving's embeddedness view of episodic and semantic memory and the unitary long-term memory position are functionally equivalent. If future studies fail to demonstrate the existence of processes that can operate upon episodic information only, then the unitary long-term memory view is the more parsimonious view and, hence, the more satisfactory of the two positions.

Although individuals can integrate episodic information across discrete audiovisual episodes and can use episodic information just as they can use semantic information to draw inferences, developmental differences in these abilities do exist. Before discussing the developmental differences in the inferential processing of episodic and semantic information, it is important to first note that memory for stimulus premises, not differences in inferential proccessing per se, was responsible for the findings that college students and seventh graders performed better than third graders on the episodic and semantic inference questions. The relatively greater episodic inference performance of seventh and third graders as compared to kindergarteners was also due to memory for stimulus premises. Differences in memory for stimulus premises do not, however, account for the difference between college students' and kindergarteners' episodic and semantic inference performance. Nor can seventh and third graders' relatively greater semantic inference performance as compared to kindergarteners' semantic

inference performance be attributed to differences in memory for stimulus premises.

If not memory for stimulus premises, what, then, could account for the findings that college students are better able than kindergarteners to integrate episodic information to derive inferences, and that college students, seventh graders, and third graders are better able than kindergarteners to use semantic information to derive inferences? Several developmental researchers have suggested that young children may not spontaneously, or automatically, integrate the information necessary for making inferences (e.g., Paris & Lindauer, 1977; Paris & Upton, 1976). Others have suggested that in lengthy comprehension tasks, older individuals may strategically search for and retrieve previously presented information from long-term memory and combine that with incoming information to increase comprehension (Brown, 1978; Flavell, Fredrichs, & Hoyt, 1970; Johnson & Smith, 1981). It may be that young children such as kindergarteners do not know to engage in this strategy (Brown, 1978; Flavell, Fredrichs, & Hoyt; Johnson & Smith, 1981), or they may not yet have the strategy automatized.

As individuals become better able to integrate information to derive inferences automatically (Paris & Lindauer, 1976; Paris, Lindauer, & Cox, 1977), requisite processing capacity should be reduced and processing should become quicker, more efficient, and automatic (Case, 1978). The decrease in the requisite operating

space should also result in an increase in available short-term memory storage space, allowing for more processing to occur (Case, 1978). This, in turn, would allow for increases in information integration (Ackerman, 1984) and for more inferences to be made. To determine if this is a viable explanation for college students' ability to derive more episodic inferences than kindergarteners do, future research must demonstrate whether kindergarteners and college students deliberately attempt to or automatically integrate episodic information to derive inferences, or whether kindergarteners do not try and/or know to integrate episodic information at all.

Several possible explanations for kindergartener's relatively lower semantic inference performance exist. First, it may be that kindergarteners do not automatically search for and retrieve semantic information for the purpose of deriving inferences. Empirical demonstrations that kindergarteners do not and that third graders, seventh graders, and college students do search for and retrieve semantic information automatically would help to explain kindergarteners' relatively lower semantic inference performance. Second, developmental differences in the semantic knowledge necessary for deriving certain inferences may be responsible for developmental differences in semantic inference performance. It may be that the kindergarteners in the present study did not possess all of the semantic knowledge necessary for deriving the semantic inferences. Requisite semantic knowledge was not assessed in the present study,

but future research of this nature should include such an assessment to determine whether developmental differences in semantic inference performance are due to differences in requisite semantic knowledge or to differences in the actual inferential processing of semantic information. Third, kindergarteners relatively lower semantic inference performance may be due to the relationship between the development of the knowledge base and the development of automatic processing. As knowledge bases increase, gaining access to associated semantic information purportedly becomes more efficient and automatic (Bjorklund, 1987; Dempster, 1981; Ornstein & Naus, 1985). The associated increase in working memory capacity would allow for more processing to occur (Bjorklund, 1987; Case, 1978) and, in turn, for more semantic inferences to be drawn. Future research assessing the extent to which individuals automatically as opposed to deliberately derive semantic inferences and assessing the semantic knowledge needed for deriving such inferences is necessary for determining which of the proposed possibilities, 1) automaticity, 2) the availability of requisite semantic knowledge, or 3) the relationship between the development of semantic knowledge and automaticity, is the most viable explanation for kindergarteners' poorer semantic inference performance.

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Figure Captions

Figure 1: Mean proportion correct episodic and semantic inference questions as a function of presentation for all three grades combined.

Figure 2: Mean proportion correct inference questions for which memory for premise information was demonstrated as a function of grade and type of inference question for integrated and separated presentation conditions.

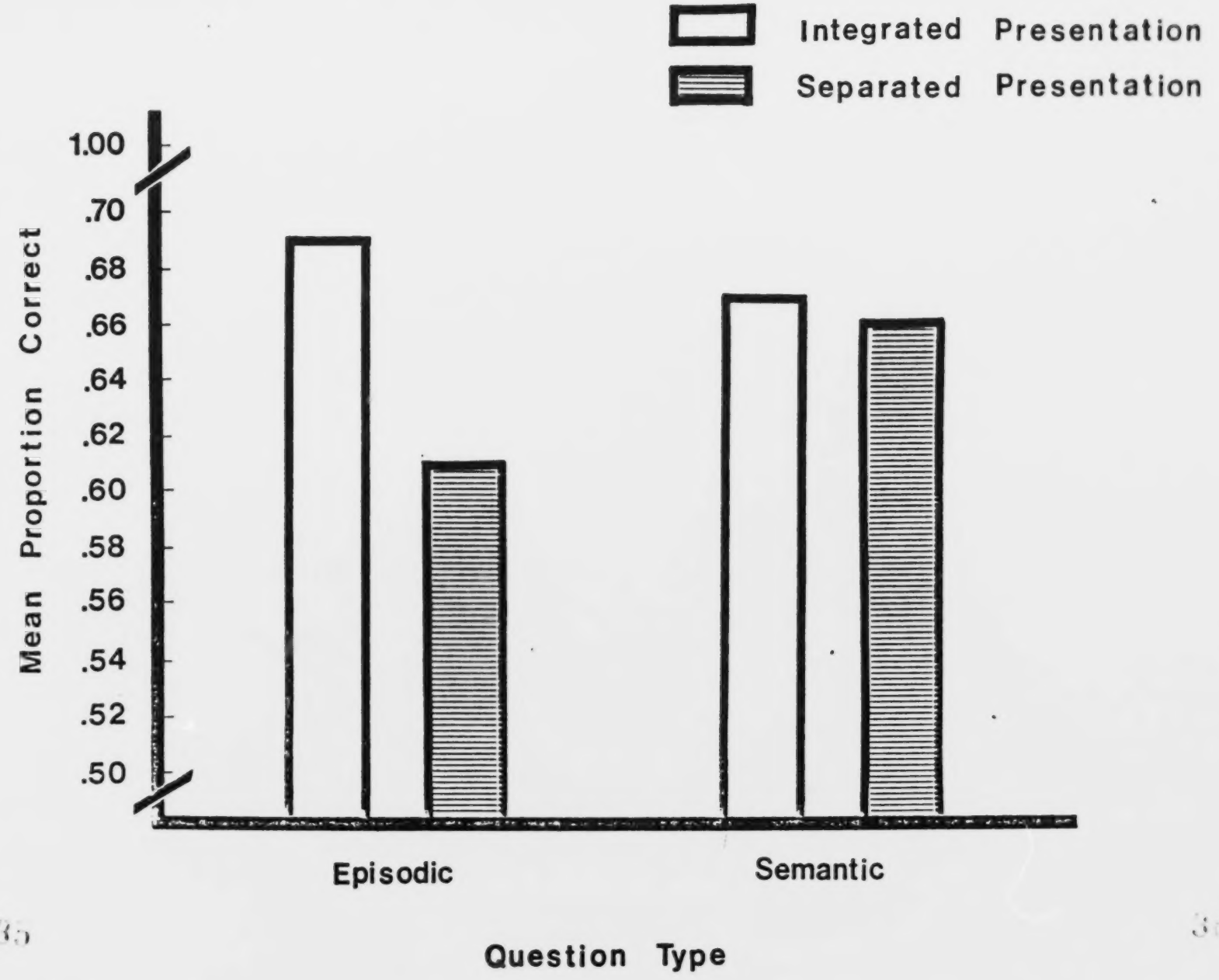
Integrated Presentation
Separated Presentation
Mean Proportion Correct
1.00
.70
.68
.66
.64
.62
.60
.58
.56
.54
.52
.50
Episodic
Semantic
Question Type

Figure 1

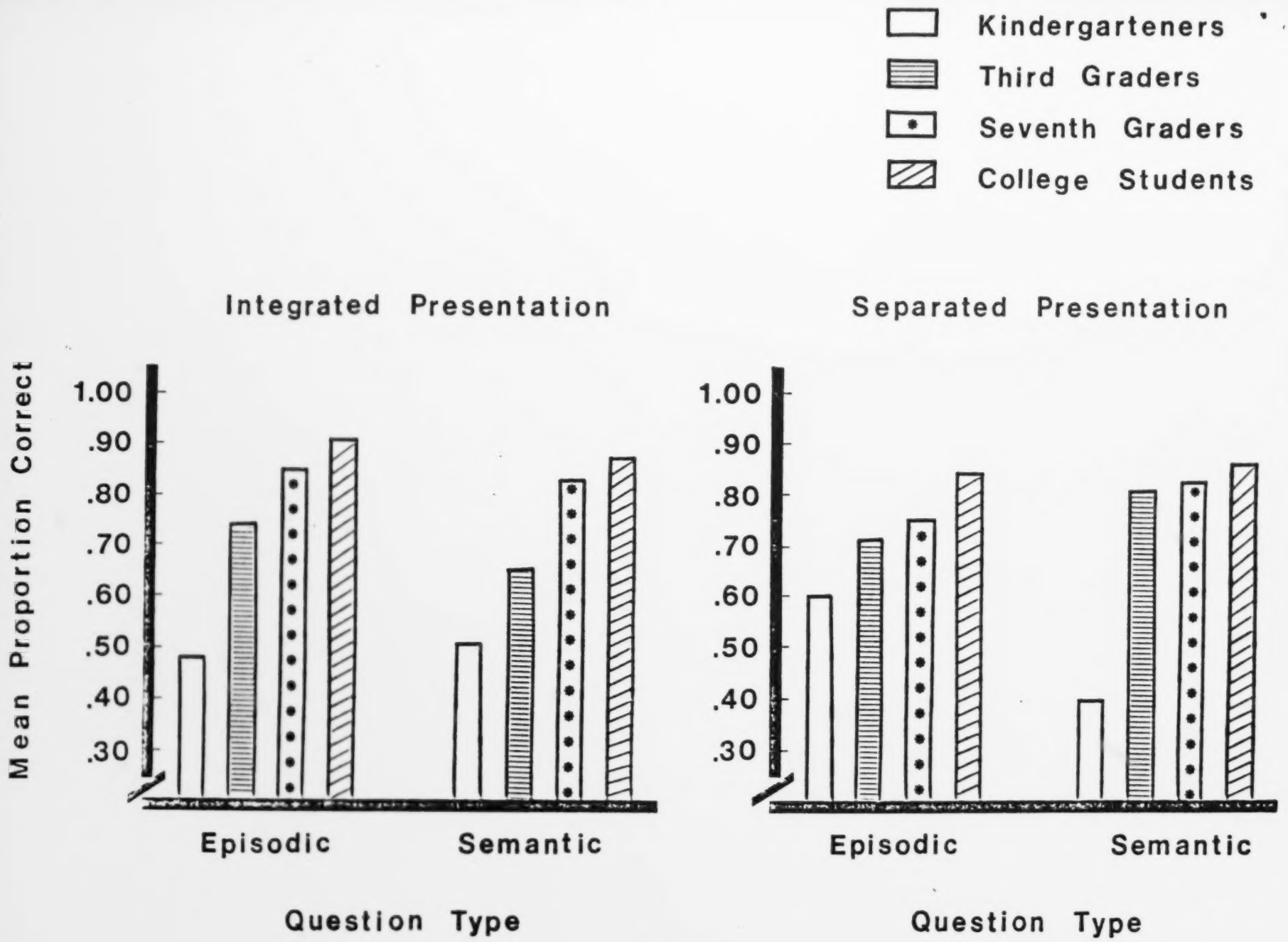
Kindergarteners
Third Graders
Seventh Graders
College Students
Integrated Presentation
Separated Presentation
Mean Proportion Correct
1.00
.90
.80
.70
.60
.50
.40
.30
Episodic
Semantic
Question Type

Figure 2